TECHNICAL INFORMATION

on the

SOLOVOX

Model K

FOR those owners who are interested in knowing exactly how the Solovox works, and for the use of any capable radio technician who may be called upon to repair the Solovox, should it ever need such service. We suggest that this booklet be kept inside the piano bench.

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MODEL K SOLOVOX

This booklet describes the Model K Solovox, which was introduced in 1946. This model differs from the original Solovox (Model J) primarily in two respects: (1) a new family of clarinet-like woodwind tones is heard by pushing in the "Mute" control, and (2) the circuit has been improved to eliminate the oscillator adjustments used on the original model.

Model J technical information is available from Solovox dealers or direct from the factory.

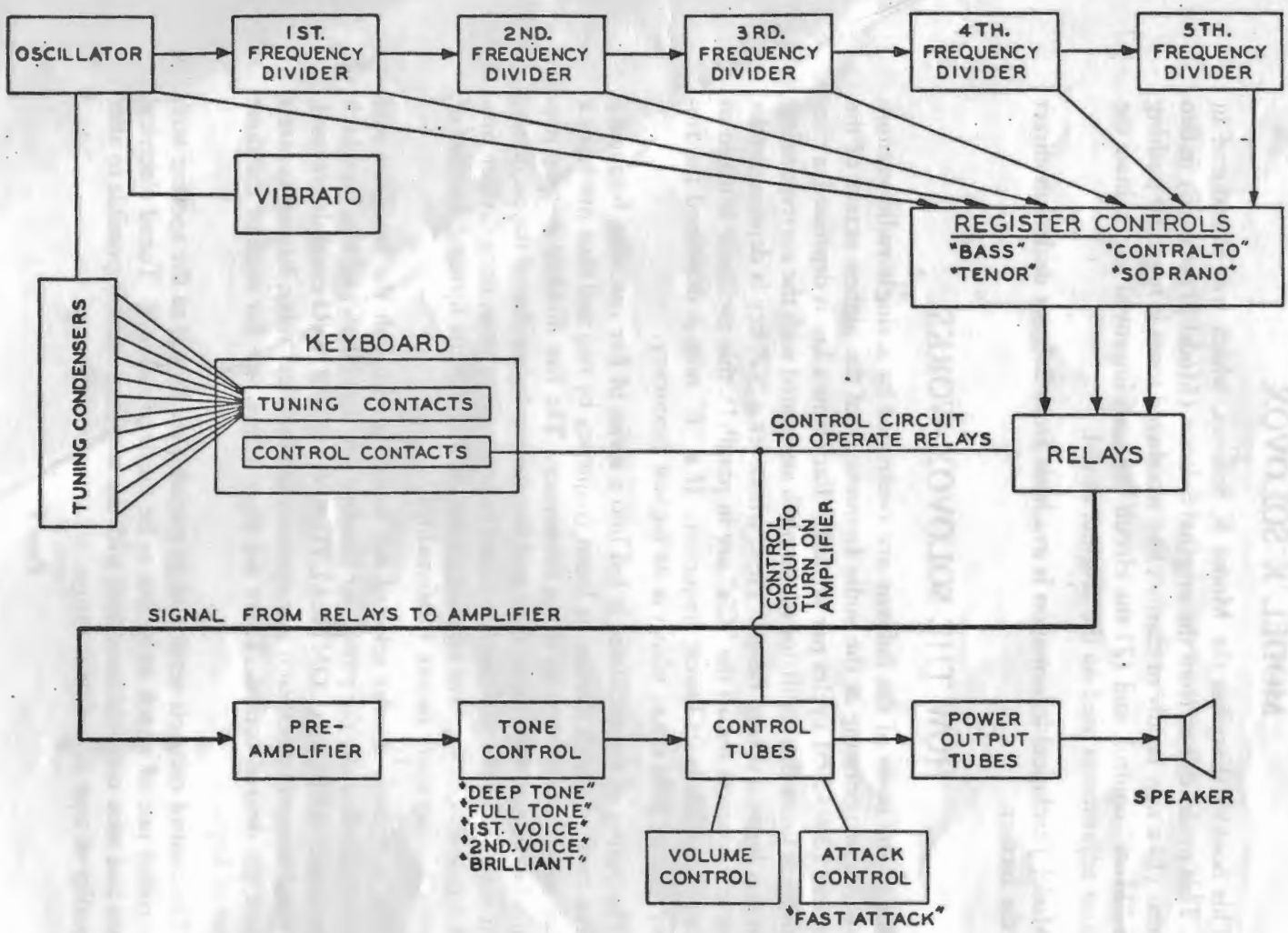
HOW THE SOLOVOX WORKS

All of the notes of the Solovox are controlled by a single radio vacuum tube oscillator operating at the audio frequencies of the highest octave of the instrument (2093-3951 cycles per second). Each time a key is depressed, a contact under it tunes this oscillator to the pitch associated with the corresponding key in this highest octave range. Thus, whenever a "C" key is depressed (the tuning key contacts for all the "C's" are in parallel), this oscillator is tuned to 2093 c.p.s., which is its lowest frequency. If a "B" note is depressed the frequency will be 3951 c.p.s., which is its highest frequency.

The output of the oscillator is fed into a series of five cascaded frequency dividers, each of which divides its input frequency by two and thus produces a note an octave lower than its input frequency. The five dividers thereby provide pitches of one, two, three, four and five octaves below that of the oscillator. In this way, when the oscillator is tuned to some given note, each divider produces a note in exact octave relation to the oscillator, thus forming a series of six notes having exact octave relationships.

The particular divider selected for sounding through the amplifier and speaker depends upon the particular playing key depressed, and also on which of the BASS, TENOR, CONTRALTO AND SOPRANO controls are used. A control contact under each key operates an electrical relay, having contacts to select the desired octave. There are three relays, one for each of the three octaves of keys.

The control contacts serve also to transmit the signal to the speaker with a controlled rate of attack so as not to be musically abrupt. Tuned electrical circuits and tone controls associated with the amplifier make it possible to alter the quality of tone over a wide range.



BLOCK DIAGRAM — SOLOVOX MODEL K

FIGURE 3

WIRING DIAGRAMS

In studying the operation of the Solovox, refer first to the block diagram (Figure 3), and second to the more detailed schematic circuit (Figure 1). It is to be noted that the arrangement of elements is exactly the same in these two drawings.

The Oscillator

The twelve condensers which tune the audio frequency oscillator to the frequencies of the highest octave, shown at the left of Figure 1, are located in the vibrato box fastened to the Solovox keyboard. There are no tuning contacts under the "B" keys, so when no key is depressed, or when any one of the three "B" keys is played, the oscillator operates at its highest frequency, 3951 cycles, the highest octave "B" note.

Whenever any other key is played, the tuning contact under it tunes the oscillator to the pitch associated with that key. For instance, when any one of the three "C" keys is depressed, the oscillator will be tuned to 2093 cycles, its lowest frequency.

Frequency Dividers

Each divider includes three triodes. One acts as a driver and pulse rectifier, supplying sharp and narrow negative pulses to actuate a symmetrical feed-back tripping circuit comprising two triodes in one 6SN7 tube. Either one (but only one) of the two triodes can be conducting at a time, for by drawing plate current it holds the other in a cut-off condition. Suppose, for example, that the first triode is conducting and the second is cut off. Now a negative input pulse impressed on the grids of both triodes will not affect the second one, which is already cut off, but will cut off the first. This produces a positive pulse at the plate of the first triode, which is applied to the grid of the second triode through its feed-back connection.

The second triode then suddenly conducts current, producing a negative pulse at its plate. This negative pulse, applied to the first triode grid through its feed-back connection, insures that the first triode remains cut off. The situation is now exactly reversed, with the first triode cut off and the second conducting.

The next input pulse will act on the second triode, cutting it off again and making the first conductive; and thus two input cycles are required to produce one output cycle. Each frequency divider circuit therefore divides its input frequency in half, producing a note an octave lower than the next preceding divider.

The output signal of each stage is taken from the plate of one triode, while the signal to drive the next divider stage comes from the second triode plate.

This divider circuit is capable of operating satisfactorily with wide variations in voltage, input frequency, and values of components, and therefore is remarkably stable and requires no adjustment.

Register Controls and Relays

From the preceding, we see that whenever any one of the three G# keys, for instance, is depressed, the frequency dividers provide a series of G# notes in exact octave relations. The selection of the particular divider output to sound through the speaker is determined by a second contact under each of the playing keys, called the CONTROL CONTACT. There are three relays connected to the control contacts — one relay is operated any time a key in the lowest octave of playing keys is depressed, another relay for the middle octave of playing keys, and a third relay for the highest octave of playing keys.

Also, whenever a control contact is closed, a cutoff bias is removed from push-pull control tubes V14 and V15, causing them to transmit the signal with a smooth rate of tonal attack to the power output tubes and speaker. This function of the control tubes will be explained subsequently.

Each of the three relays has a contact to connect the grid of the preamplifier tube V13 to the desired divider through the register controls ("BASS-TENOR-CONTRALTO-SOPRANO"). For example, if we push in the "SOPRANO" control and depress the G key in the middle of the keyboard, the tuning contact will tune all the dividers to the G notes of their respective octaves, and the control contact will operate the middle octave relay. This relay completes a circuit from the output of the first frequency divider, whose wire is numbered 28, through a 50,000 ohm register control resistor to the middle octave relay contact, and then to the

preamplifier tube V13. Thus, the register controls function to shift the pitch range of the Solovox keyboard as a whole to four different positions. By simultaneously depressing two or more of these controls, a composite tone will be heard, consisting of the outputs of several dividers simultaneously sounding in their octave relations to each other.

Other contacts associated with each of the relays serve to prevent undesirable tones from occurring when two keys are simultaneously depressed in adjoining octave groups through a legato style of playing on the part of the musician. If two keys are depressed within one of the three octave groups, the lower pitched of the two will be automatically selected for sounding through the speaker.

The Mute

Six half wave rectifiers, in three double diode tubes V10, V11, and V12, are normally shunted from ground to the six output wires of the oscillator and frequency dividers. The tone thus produced (with the mute switch off) is a string family of odd as well as even harmonics. When the six diodes are disconnected by turning the mute switch on, the clarinet family of tones (containing odd harmonics only, as generated by the frequency dividers) is produced.

Note: Model J Solovox (See Page 1) has a different mute circuit.

"Deep Tone," "Full Tone," "First Voice," "Second Voice," and "Brilliant" Controls

Following the preamplifier is a series of tone controlling circuits arranged to alter the frequency characteristic of the amplifier in a manner similar to radio tone controls. For instance, with "DEEP TONE" the signal develops across a condenser which emphasizes the low frequencies; with "FULL TONE" the signal develops across a resistor with a small condenser in shunt, which leaves the frequency characteristic essentially flat except for the very high frequencies; "FIRST VOICE" puts a resonance in the 400 cycle zone; "SECOND VOICE" puts a resonance near 800 cycles; and with "BRILLIANT" the signal develops across an inductance, L10, emphasizing the higher frequencies. It is to be noted that these tone control circuits are connected in series, and may be used singly or in groups.

Control Tubes V14 and V15

As mentioned before, the control contacts under the playing keys serve to remove the cutoff bias from control tubes V14 and V15, as well as to operate one of the three relays. This is explained by considering that the cathodes of tubes V14 and V15 are connected to the mid-point of the voltage divider shown to the left of the control tubes in Figure 1. When no playing key is down, this voltage is about 175 volts positive with respect to ground, and, therefore, these tubes are cut off. When any playing key control contact is closed, the resistance of the relay coil is put in parallel with the 6000 ohm resistor and this causes the cathode voltage to drop to 55 volts. This removes the cutoff bias from tubes V14 and V15, which are of the remote cutoff type. The 15 mfd. condenser across the 6000 ohm resistor serves to make the tonal attack and decay rate smooth. A .1 mfd. condenser connected between the control tube cathode and the center tap of transformer T9 produces a slow rate of attack but can be disconnected if desired by operating the "fast attack" switch.

Volume Control

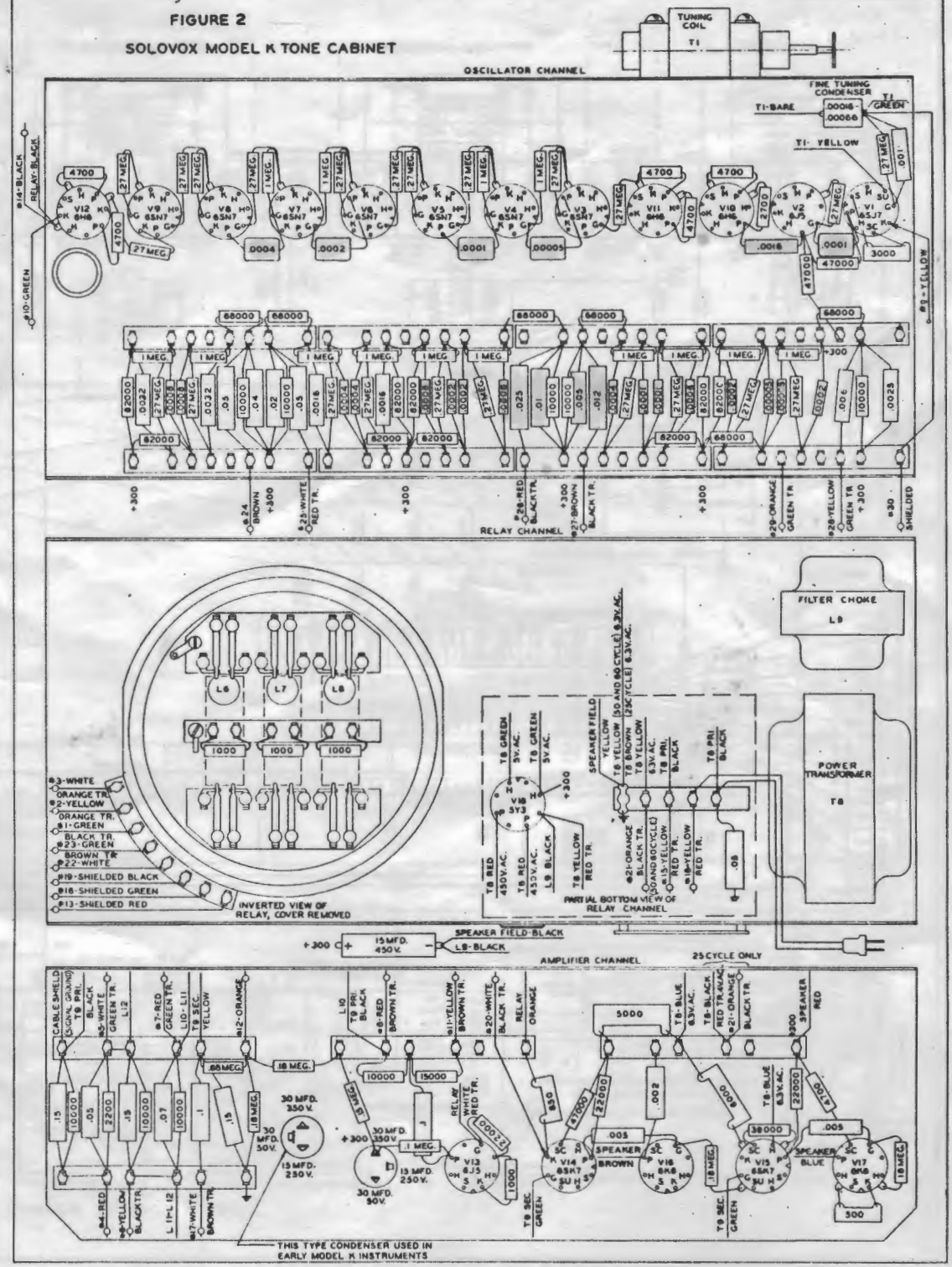
The volume of the Solovox is controlled by a knee-operated rheostat. This rheostat is actually a switch connected to seven fixed resistors, and is, therefore, not subject to wear as is the usual type of volume control. This rheostat forms part of a voltage divider circuit which varies the grid bias to the remote cutoff control tubes V14 and V15, and, therefore, changes the gain of these tubes to produce a corresponding change of volume in sound from the speaker. The grid potential varies from approximately +45 volts at the maximum volume position (depending on setting of maximum volume control), to approximately ground potential at the minimum position (depending on setting of minimum volume control).

The Vibrato

The vibrato effect is produced by means of a magnetically driven reed having a small piece of powdered iron attached to it in such a way as to vibrate in and out of a coil placed beside the reed. Thus, the inductance of the coil varies periodically as the powdered iron core swings in and out of it. This coil is connected to a tap on the master oscillator tuning coil,

FIGURE 2

SOLOVOX MODEL K TONE CABINET



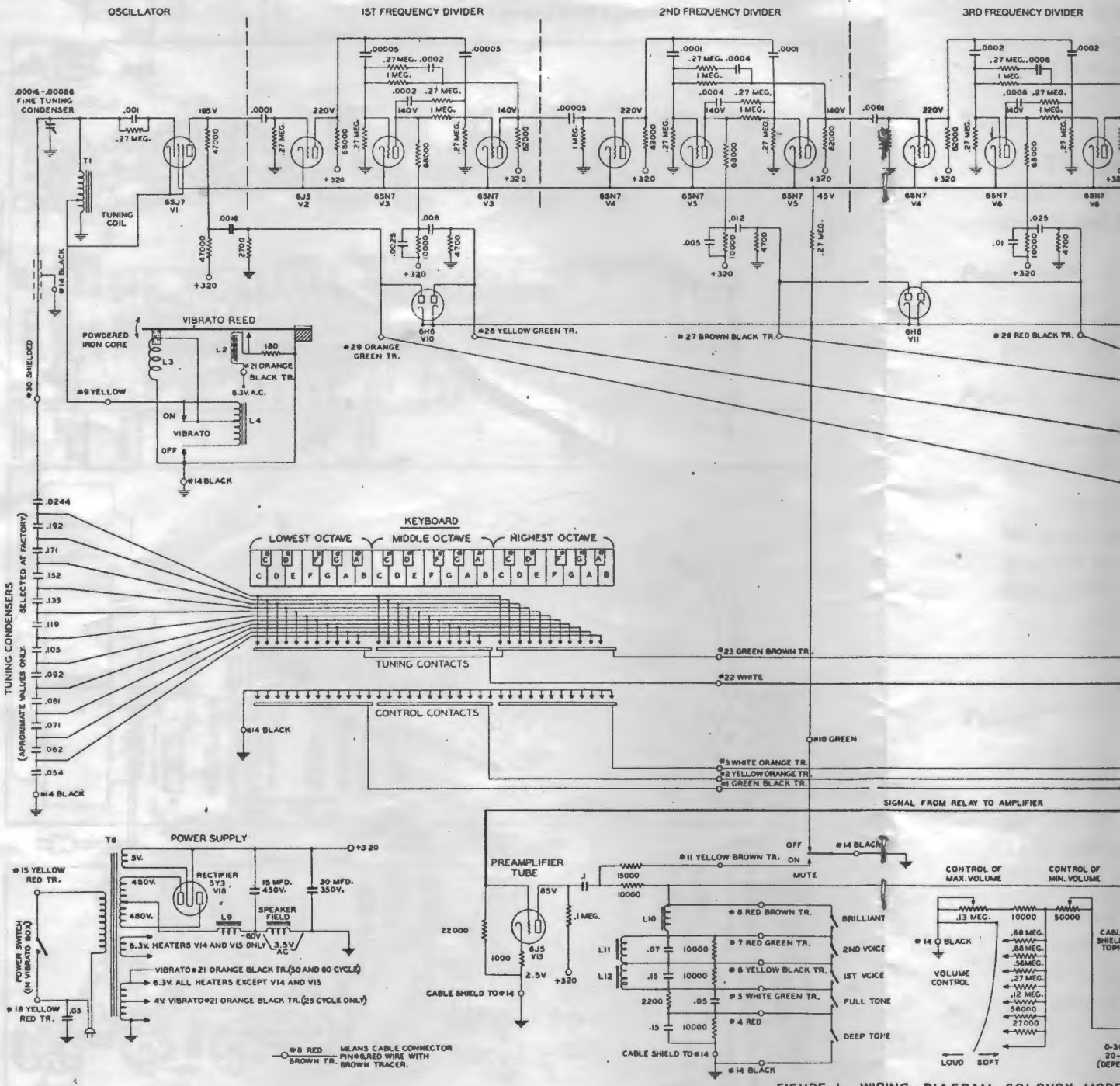


FIGURE 1 WIRING DIAGRAM SOLOVOX MODE

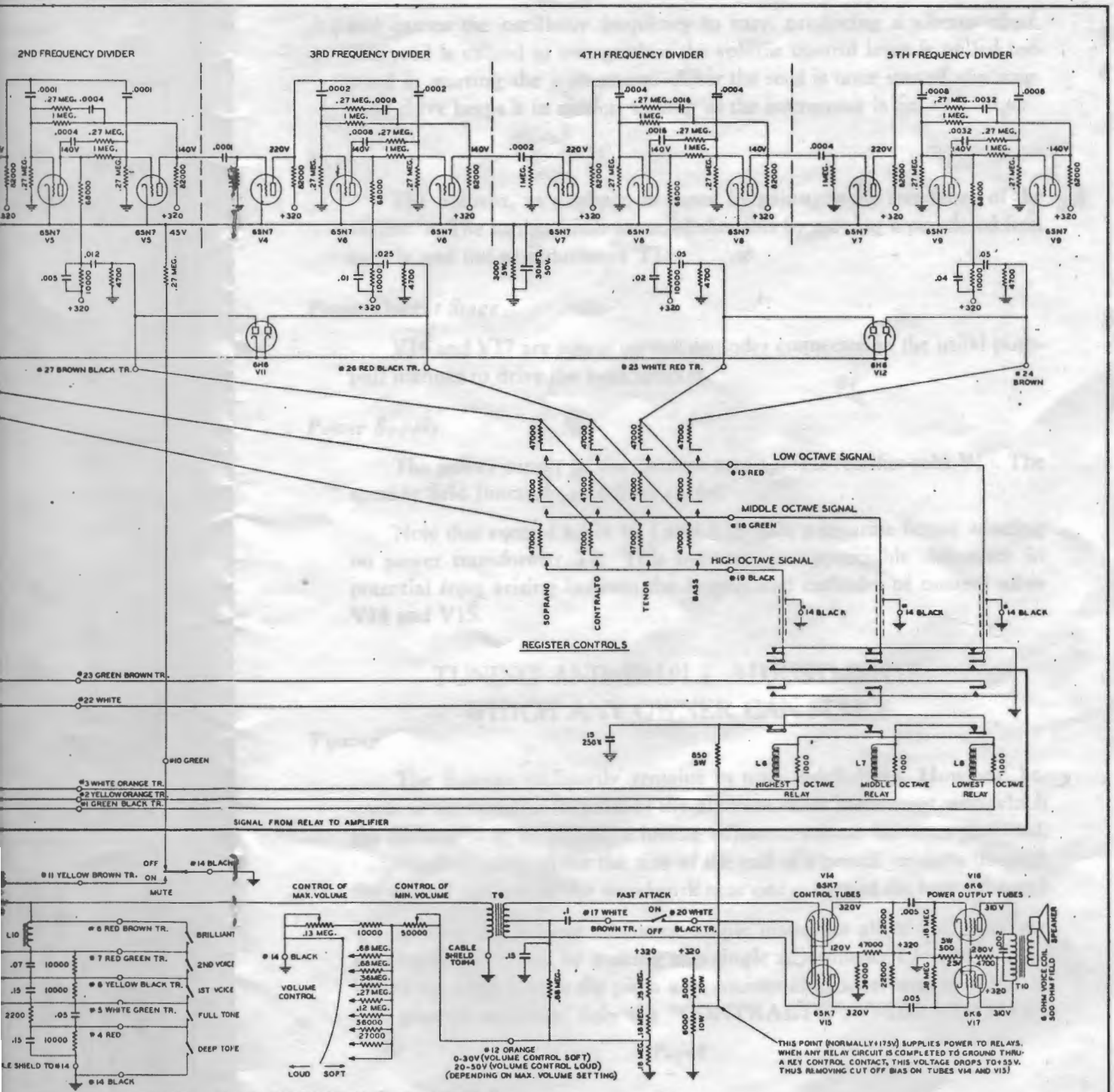
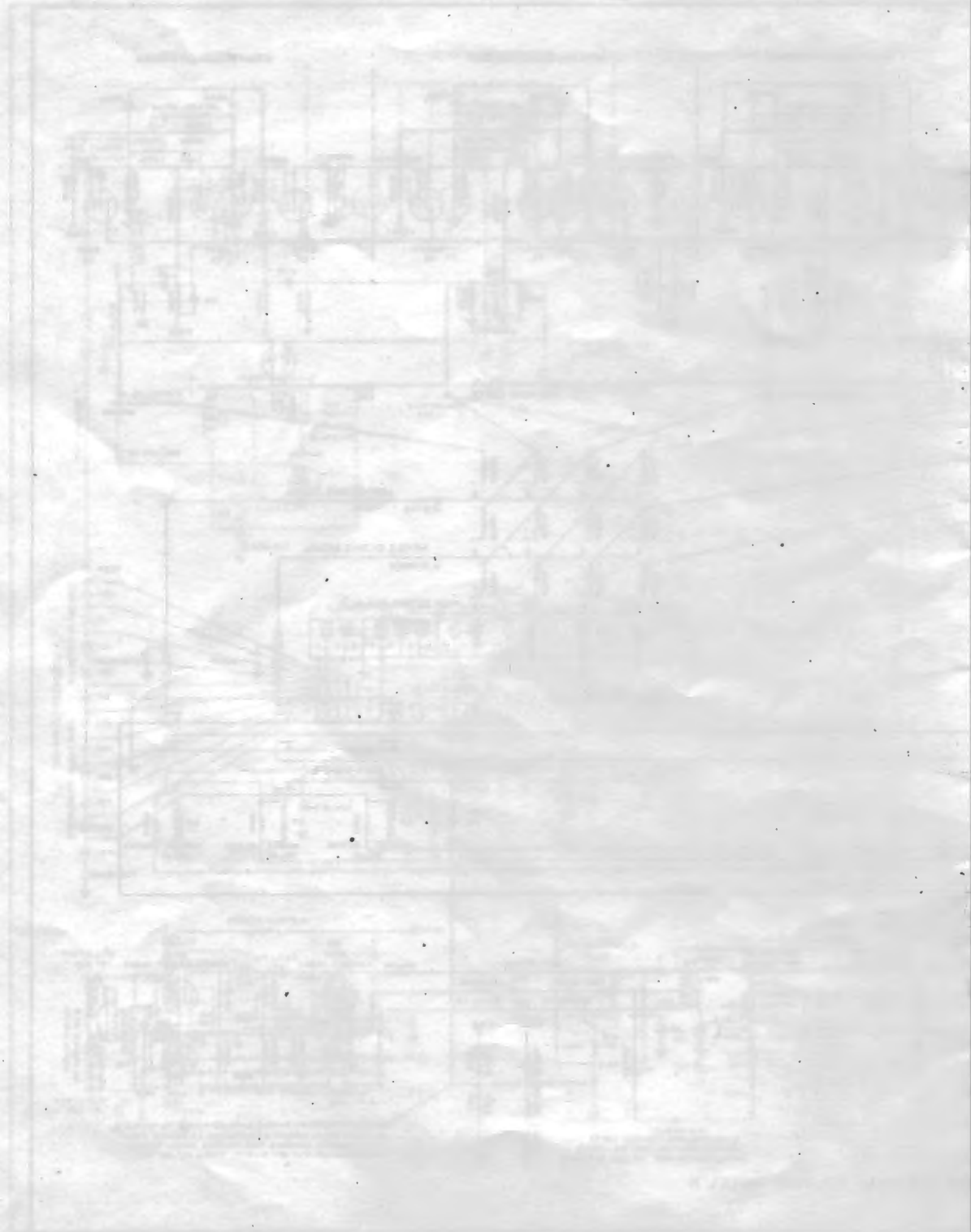


FIGURE 1 WIRING DIAGRAM SOLOVOX MODEL K



and causes the oscillator frequency to vary, producing a vibrato effect. The reed is caused to swing when the volume control lever is pulled forward in starting the instrument. After the reed is once started, the magnetic drive keeps it in motion as long as the instrument is on.

Tuning

The Solovox, as a whole, is tuned by adjusting the frequency of the oscillator. The tuning knob accomplishes this by moving a powdered iron core in and out of inductance T1.

Power Output Stage

V16 and V17 are power output pentodes connected in the usual push-pull manner to drive the loud speaker.

Power Supply

The power supply of the Solovox uses a single rectifier tube V18. The speaker field functions as a filter choke.

Note that control tubes V14 and V15 have a separate heater winding on power transformer T8. This prevents an appreciable difference in potential from arising between the heaters and cathodes of control tubes V14 and V15.

TUNING AND SIMPLE ADJUSTMENTS WHICH ANY OWNER CAN MAKE

Tuning

The Solovox ordinarily remains in tune indefinitely. However, because of the variation in pitch of the piano or other instrument with which the Solovox is to be played, a tuning adjustment knob has been provided. (The tuning knob, about the size of the end of a pencil, projects through the curved surface of the woodwork near one corner of the tone cabinet.)

Tuning the Solovox is a very simple matter as all of the tones are simultaneously tuned by making this single adjustment. Clockwise turning of the knob lowers the pitch and counter-clockwise turning raises it. For greatest accuracy, only the "CONTRALTO", "VIBRATO OFF"

and "DEEP TONE" control tablets should be "in" and the middle octave F# key of the Solovox tuned to the corresponding piano note. (A control tablet is "in" when the top of the tablet is pushed in.)

Adjustment of Maximum and Minimum Volume Controls

The maximum volume control knob is located under the keyboard to the left of the volume control. It regulates the maximum loudness when the knee-operated lever is all the way to the right.

The minimum volume control is located a little farther to the left, and is provided with a screwdriver slot for adjusting. It is used to regulate the minimum loudness when the knee-operated lever is all the way to the left.

When readjusting both controls, always set the minimum volume control first, as it has some effect on the maximum volume as well. To do this, set the tablets to some useful setting such as "CONTRALTO" and "DEEP TONE". With the knee-operated volume control released, so that it points directly out, hold down a key and turn the slotted minimum volume control until the note is as soft as is useful. (When once set this control will probably not need to be changed. If you ever move it, be sure to check the maximum volume afterwards.)

To adjust the maximum volume control knob, move the knee-operated volume control as far as it will go to the right, holding down a key, and turn the knob to the right until the volume becomes as loud as is useful. Do not turn the knob to the right any further as to do so will only mean that the knee-operated volume control will become unnecessarily sensitive which is particularly undesirable for the novice and beginner.

PRACTICAL SERVICE SUGGESTIONS

The materials and electrical parts in the Hammond Solovox are of the finest quality available. Aside from occasional replacement of a vacuum tube, no service problems need be expected to arise. A few conditions which might possibly be encountered are listed below with information which will enable a radio service technician to correct them without difficulty.

1. *Cable connector.* In case the Solovox fails to play correctly, first make sure that the cable connector in the left end of the keyboard under the piano is

secure. The face of the plug and its receptacle should be together. If the Solovox does not play properly, this is the most likely cause.

2. *Replacing tubes.* There are eighteen tubes in the Solovox: three type 6H6, two type 6J5, two type 6K6, one type 6SJ7, two type 6SK7, seven type 6SN7, and one type 5Y3. These are all standard radio tubes, and can be tested and replaced, if necessary, by any radio dealer. All tubes can be reached from the back of the tone cabinet. A metal guard covering the lower row of tubes is easily removed by taking out two screws — see Fig. 4. Be sure to replace all tubes in the exact sockets from which they came.

The two type 6SK7 control tubes (V14 and V15, located in the amplifier channel, Fig. 4) should be similar to avoid undesirable thumps when playing. It is therefore recommended that both be replaced at the same time with new tubes of the same make.

3. *Instrument fails to play.* Ordinarily in this case all the tubes should be tested. If the tubes are lighted, the cable plug is making proper connection, and the controls are in playing position, the most likely source of trouble is the amplifier circuit. In most respects this is a conventional amplifier circuit, and the voltage measurements given on page 14 will enable a radio service technician to locate the trouble.

A dirty key contact may cause an irregular sputtering or crackling of a single note. In this case, move the bus-bar shifters as described in the following suggestions numbered "6" and "7".

4. *One octave of keys does not play.* If a single octave of the Solovox keyboard fails to play for any combination of register controls, the trouble is probably in the relay associated with that octave or a wire leading to it. The voltage at the 850 ohm resistor (where the orange wire connects to it) should be 175V. with no key pressed and should drop to 30V. with a key down. The control tube cathodes (V14 and V15) should also show 175V. with no key pressed.

If a single octave of the keyboard fails to play on one register control, but plays correctly with all other controls, the register control tablet probably has a dirty contact. It may be cleared by removing the left section of the control panel (which includes the four register controls) and wiping the contacts carefully.

5. *One octave of tones does not play.* A broken cable wire or poor plug connection in the output circuit of a single frequency divider will cause one octave of tones to be missing for any combination of keys and register controls employing that particular divider. The following chart will be helpful in finding the frequency divider associated with notes of any particular octave.

	Lowest Octave of Playing Keys	Middle Octave of Playing Keys	Highest Octave of Playing Keys
"BASS' control connects to.....	5th divider	4th divider	3rd divider
"TENOR" control connects to.....	4th divider	3rd divider	2nd divider
"CONTRALTO" control connects to.	3rd divider	2nd divider	1st divider
"SOPRANO" control connects to....	2nd divider	1st divider	Oscillator

In case the frequency divider itself is not operating, all octaves below it will also fail to play. A cathode-ray oscilloscope connected from ground to the plate of any divider tube should show a rectangular wave, while the plate of any divider driver tube should show a very sharp and narrow negative pulse.

6. *One key does not sound.* If a certain key fails to play on any of the register controls, it probably has a dirty control contact which can be cleared easily by shifting the control contact bus-bar, whose adjustment is at the right end of the keyboard under the molded bakelite end piece. A drawing accompanying the keyboard (Fig. 5) shows how the contact shifters are arranged. Loosen the clamping screw, shift the bus-bar about 1/32", and tighten the clamping screw carefully.

7. *One key plays note "B" instead of its correct pitch (with adjacent keys playing correctly).* In this case the key has a dirty tuning contact which can be cleared easily by shifting the tuning contact bus-bar, whose adjustment is at the left end of the keyboard. Adjust as described in the preceding paragraph.

8. *All keys in one octave play note "B".* This means that a cable wire (#22 or #23) is disconnected or a contact on the corresponding relay is dirty.

9. *Key thumps or clicks.* If a transient effect in the form of an annoying thump appears each time a key is released, the two type 6SK7 control tubes (V14 and V15) are probably not matched properly. In this case, install two new tubes of the same make. A loud click each time a key is released indicates that the control tube cathode condenser (15 mfd. 250V.) is probably open or partially open.

10. *Hum.* An excessive 120 cycle hum in the speaker indicates that the filter choke (L9) is defective or one of the filter condensers is open or low in capacity.

11. *Adjustment of Fine Tuning Condenser.* An additional tuning adjustment is provided in the form of a screw driver operated trimming condenser at the back of the tone cabinet, upper left hand corner (See Fig. 4). After several years of use under very adverse conditions of humidity, or if exceedingly accurate tuning is required, this adjustment may need to be made. First, however, always tune as described on page 9. If, after tuning F#, it is found that other notes (most likely C or B) are out of tune, the tuning breadth of the octave may be readjusted as follows:

(a) Depress the middle "C" key with the "VIBRATO OFF", "CONTRALTO", and "DEEP TONE" controls pushed in. Tune to a well-tuned piano, by adjusting the tuning knob of the tone cabinet. If it is found impossible to tune the "C" with the tuning knob, the two wood screws at the top of the tuner may be loosened, and the black bakelite tube moved to a position in the tuning coil such that the range of the tuning knob does cover the correct "C" pitch. Before making this adjustment, be sure the "VIBRATO" switch tablet is not set midway between its on and off positions. For tuning purposes, the "VIBRATO" tablet should be pushed in at the top of the tablet.

(b) After tuning the "C" key with the tuning knob, depress a "B" key and tune to zero beat with the screw driver operated trimming condenser located in back of the tone cabinet (see Fig. 4).

(c) The "C" notes will now be slightly off pitch. Depress a "C" key and tune again to zero beat with the tuning knob.

(d) Depress a "B" key and tune to zero beat again with the trimming condenser.

(e) Repeat step (c).

(f) Repeat step (d). The instrument will now be exceedingly accurately tuned.

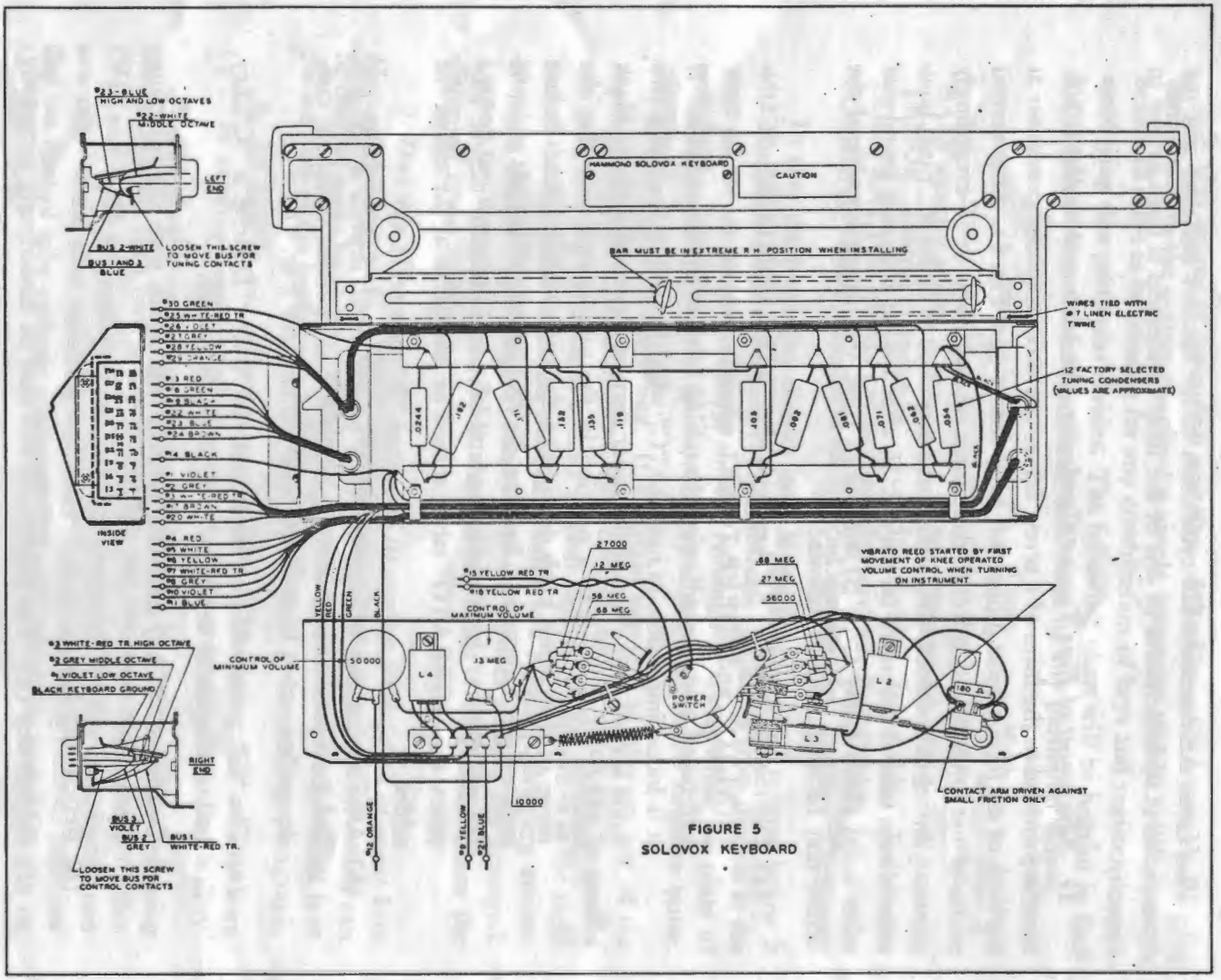


FIGURE 5
SOLOVOX KEYBOARD

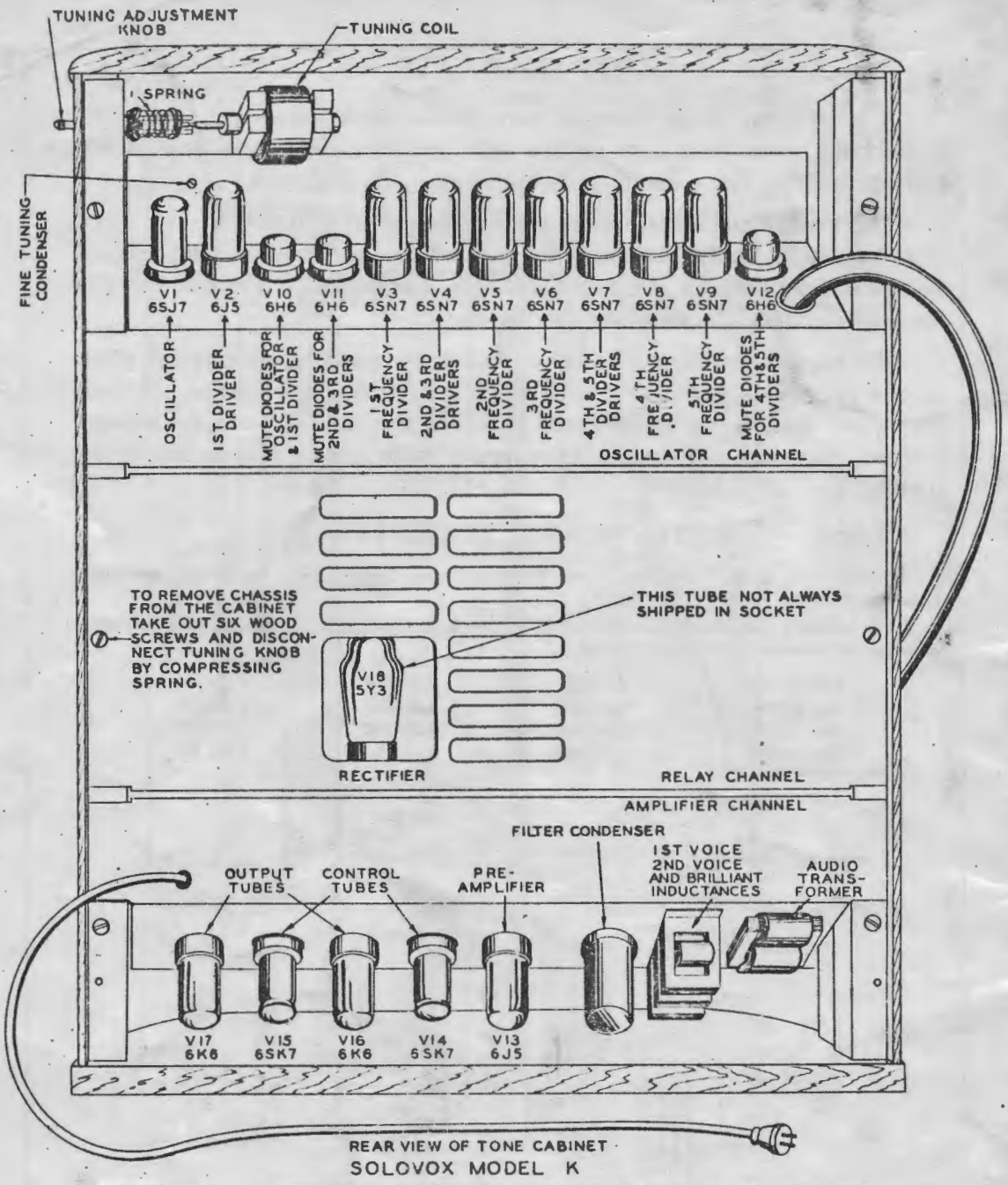
REPAIR PARTS

A great many of the electrical parts are standard radio parts, obtainable at any radio store. Such parts include tubes, resistors, condensers, both paper and electrolytic. The correct values are given in the diagrams.

The chokes and transformers are mostly special. To obtain such parts from us specify the model and serial number of your Solovox tone cabinet and the designation used in Figures 1, 2, or 5. For example: Transformer T9, for Solovox Model K, serial number 55000.

We suggest that if your Solovox should ever need repair you call your nearest Hammond dealer, or ask us where nearest dealer is located. If your Hammond dealer is not conveniently available, this booklet, with the accompanying diagrams, will enable a competent radio service man to locate the trouble.

PATENTS AND TRADEMARKS



REAR VIEW OF TONE CABINET
SOLOVOX MODEL K

FIGURE 4

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